# High Intensity Radiated Field (HIRF) Regulations

Ft. Worth ACO DER Seminar

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# Presentation Topics

- Current FAA HIRF special conditions
- HIRF NPRM
  - Definition of HIRF environment
  - Description of NPRM
  - Differences from special condition
  - Differences between parts 23, 25, 27 & 29
- Proposed advisory circular
  - Compliance methods

# Airship Industries Airship 600 Accident

- April 15, 1990, Airship Industries Airship 600 traversed the beam of a highly directional RF broadcast from Voice of America transmitter near Greenville, NC.
- Suffered a complete loss of power in both engines due to the failure of both ignition units.
- Airship conducted a forced landing in North Carolina

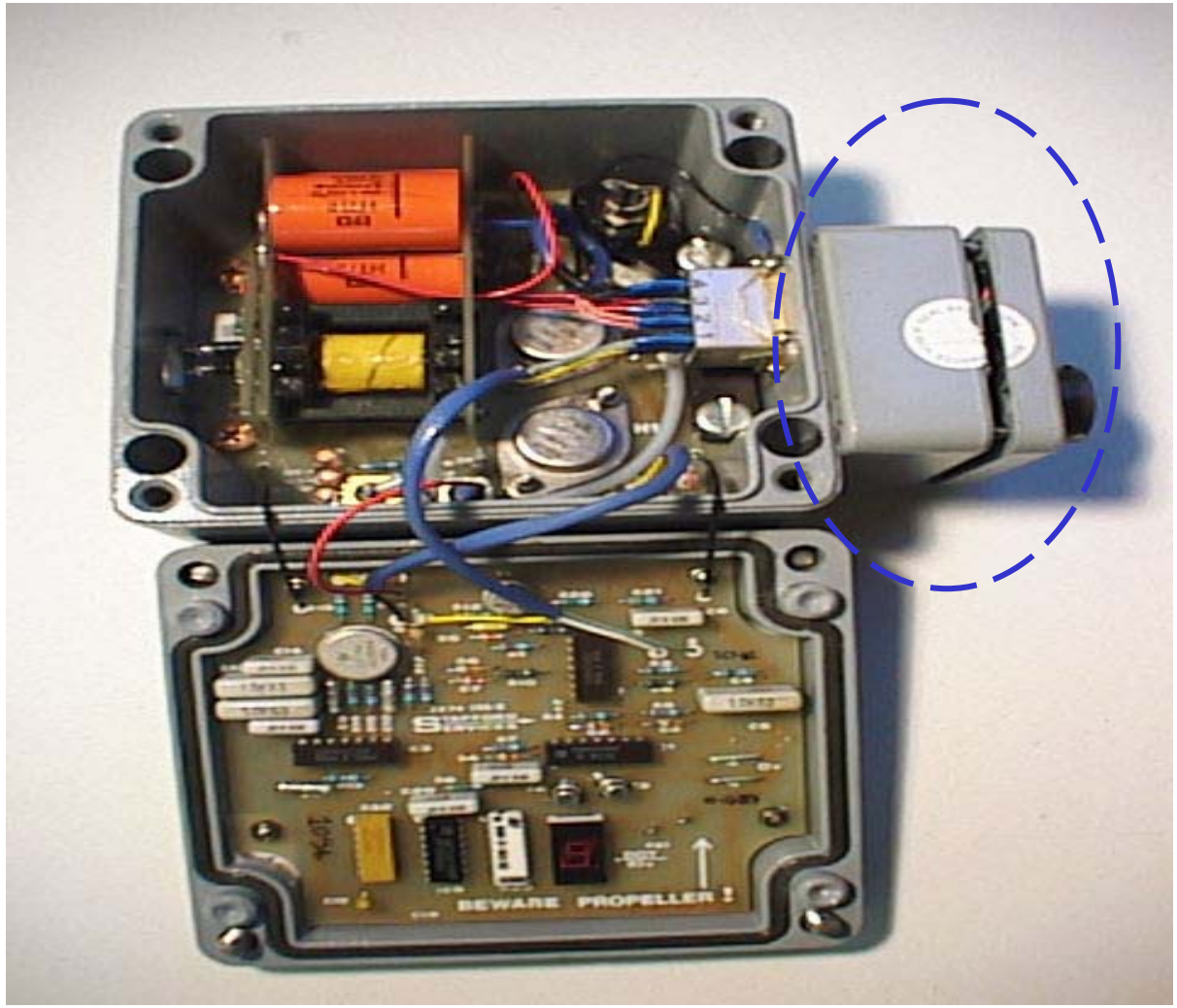
# Airship 600


# Airship Industries Airship 600 Accident

- Investigation found resistors failed on both engines ignition controls
- The ignition units were redesigned to add a filter assembly
- Retested successfully to 100 v/m
- NTSB probable cause listed contributing factor: *Lack of HIRF certification standards for airships at the time of the airship's certification was a factor in the accident*.

# Airship Industries Airship 600 Accident

- Engine control with additional filter assembly at connector



# Current HIRF Special Conditions

- HIRF special conditions have been applied since 1987
- Based on HIRF Notice N8110.71
- Applies to systems that perform '*functions whose failure would contribute to or cause a failure condition that would prevent the continued safe flight and landing of the airplane*'.

# Special Condition Compliance Approach 1

For small airplanes and transport airplanes:

A minimum of 100 volts per meter rms electric field strength from 10 kHz to 18 GHz, applied to the system elements and their associated wiring harnesses without the benefit of airframe shielding, through system tests and analysis.

For helicopters:

Same as above, except a minimum of 100 volts per meter for critical display systems, and a minimum of 200 volts per meter for critical control functions.

# Special Condition Compliance Approach 2

A threat external to the airframe of the following field strengths for the frequency ranges indicated.

| Frequency | Field strength (volts/meter) | |
|---|---|---|
| | Peak | Average |
| 10 kHz - 2 MHz | 50 | 50 |
| 2 MHz - 30 MHz | 100 | 100 |
| 30 MHz - 100 MHz | 50 | 50 |
| 100 MHz - 400 MHz | 100 | 100 |
| 400 MHz - 700 MHz | 700 | 50 |
| 700 MHz - 1 GHz | 700 | 100 |
| 1 GHz - 2 GHz | 2,000 | 200 |
| 2 GHz - 6 GHz | 3,000 | 200 |
| 6 GHz - 8 GHz | 1,000 | 200 |
| 8 GHz - 12 GHz | 3,000 | 300 |
| 12 GHz - 18 GHz | 2,000 | 200 |
| 18 GHz - 40 GHz | 600 | 200 |

# HIRF Notice of Proposed Rulemaking

- NPRM published for comment February 1, 2006
- Advisory Circular Notice of Availability published for comment February 1, 2006

  Both can be found under 'Federal Aviation Administration' at:

  http://www.access.gpo.gov/su_docs/fedreg/a060201c.html
- Comment period for both closed May 2, 2006
- Contact for both is Rich Jennings, FAA AIR-130

# Proposed HIRF Regulations

- New regulations proposed for parts 23, 25, 27 and 29
- Based on proposals from ARAC Electromagnetic Effects Harmonization Working Group (EEHWG)
- Similar to existing JAA/EASA HIRF certification review items (CRI)

# § 23.1308(a) High-intensity Radiated Fields (HIRF) Protection.

(a) Each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the airplane must be designed and installed so that—

(1) The function is not adversely affected during and after the time the airplane is exposed to HIRF environment I, as described in appendix J to this part;

(2) The system automatically recovers normal operation, in a timely manner, after the airplane is exposed to HIRF environment I, as described in appendix J to this part, unless the system's recovery conflicts with other operational or functional requirements of the system; and

(3) The system is not adversely affected during and after the time the airplane is exposed to HIRF environment II, as described in appendix J to this part.

# § 23.1308(b)

(b) Each electrical and electronic system that performs a function whose failure would significantly reduce the capability of the airplane or the ability of the flightcrew to respond to an adverse operating condition must be designed and installed so the system is not adversely affected when the equipment providing the function is exposed to equipment HIRF test level 1, 2, or 3, as described in appendix J to this part.

# § 23.1308(c)

(c) Each electrical and electronic system that performs a function whose failure would reduce the capability of the airplane or the ability of the flightcrew to respond to an adverse operating condition must be designed and installed so the system is not adversely affected when the equipment providing the function is exposed to equipment HIRF test level 4, as described in appendix J to this part.

# Appendix J to Part 23—HIRF Environments and Equipment HIRF Test Levels

This appendix specifies the HIRF environments and equipment HIRF test levels for electrical and electronic systems under § 23.1308. The field strength values for the HIRF environments and equipment HIRF test levels are expressed in root-mean-square units measured during the peak of the modulation cycle.

# Table I. - HIRF Environment I (Certification)

| Frequency | Field strength (volts/meter) | |
|---|---|---|
| | Peak | Average |
| 10 kHz - 2 MHz | 50 | 50 |
| 2 MHz - 30 MHz | 100 | 100 |
| 30 MHz - 100 MHz | 50 | 50 |
| 100 MHz - 400 MHz | 100 | 100 |
| 400 MHz - 700 MHz | 700 | 50 |
| 700 MHz - 1 GHz | 700 | 100 |
| 1 GHz - 2 GHz | 2,000 | 200 |
| 2 GHz - 6 GHz | 3,000 | 200 |
| 6 GHz - 8 GHz | 1,000 | 200 |
| 8 GHz - 12 GHz | 3,000 | 300 |
| 12 GHz - 18 GHz | 2,000 | 200 |
| 18 GHz - 40 GHz | 600 | 200 |

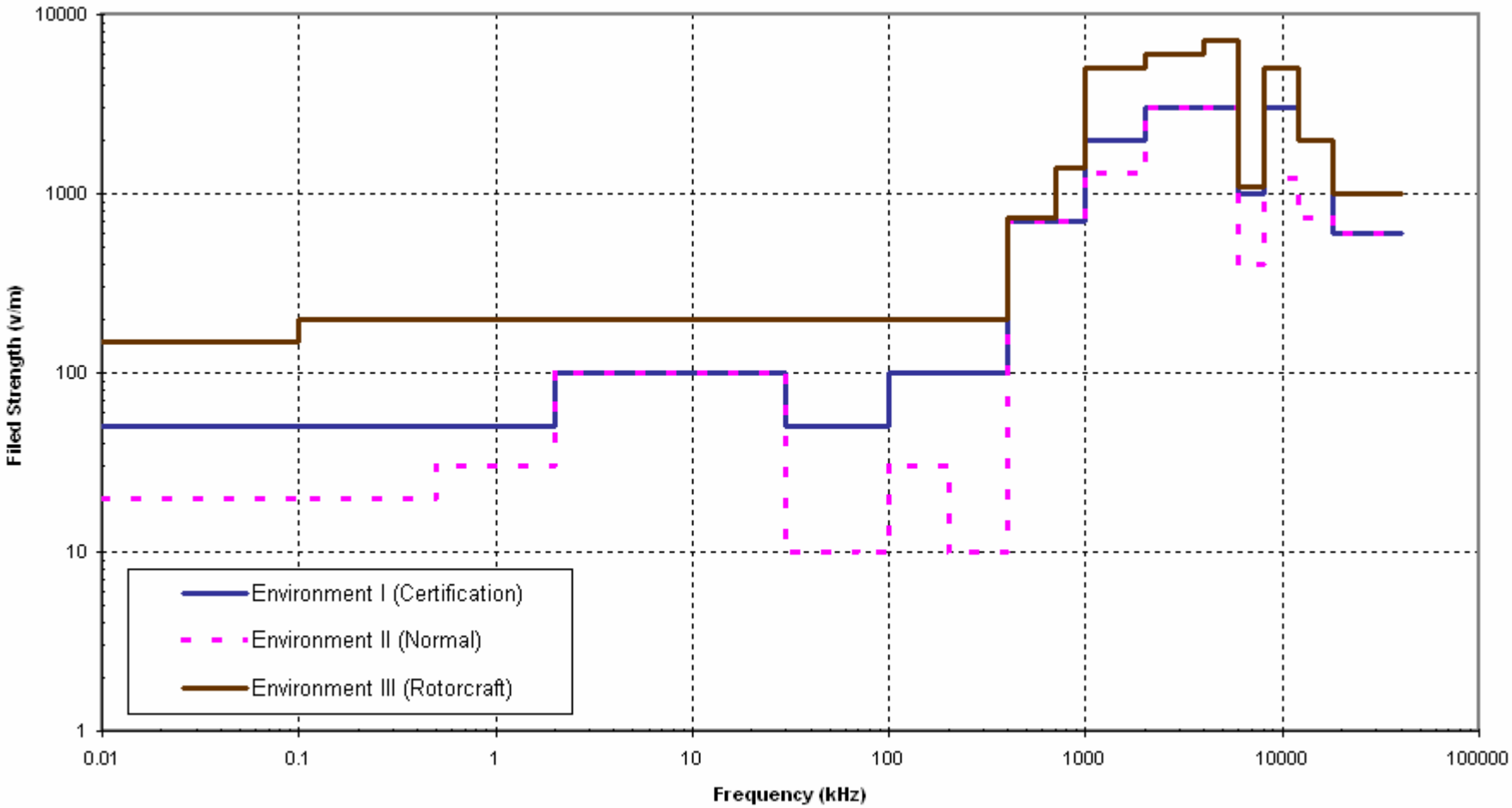
# Table II. - HIRF Environment II (Normal)

| Frequency | Field Strength (Volts/Meter) | |
|---|---|---|
| | Peak | Average |
| 10 kHz – 500 kHz | 20 | 20 |
| 500 kHz -- 2 MHz | 30 | 30 |
| 2 MHz -- 30 MHz | 100 | 100 |
| 30 MHz -- 100 MHz | 10 | 10 |
| 100 MHz – 200 MHz | 30 | 10 |
| 200 MHz – 400 MHz | 10 | 10 |
| 400 MHz – 1 GHz | 700 | 40 |
| 1 GHz -- 2 GHz | 1,300 | 160 |
| 2 GHz -- 4 GHz | 3,000 | 120 |
| 4 GHz -- 6 GHz | 3,000 | 160 |
| 6 GHz -- 8 GHz | 400 | 170 |
| 8 GHz -- 12 GHz | 1,230 | 230 |
| 12 GHz -- 18 GHz | 730 | 190 |
| 18 GHz -- 40 GHz | 600 | 150 |

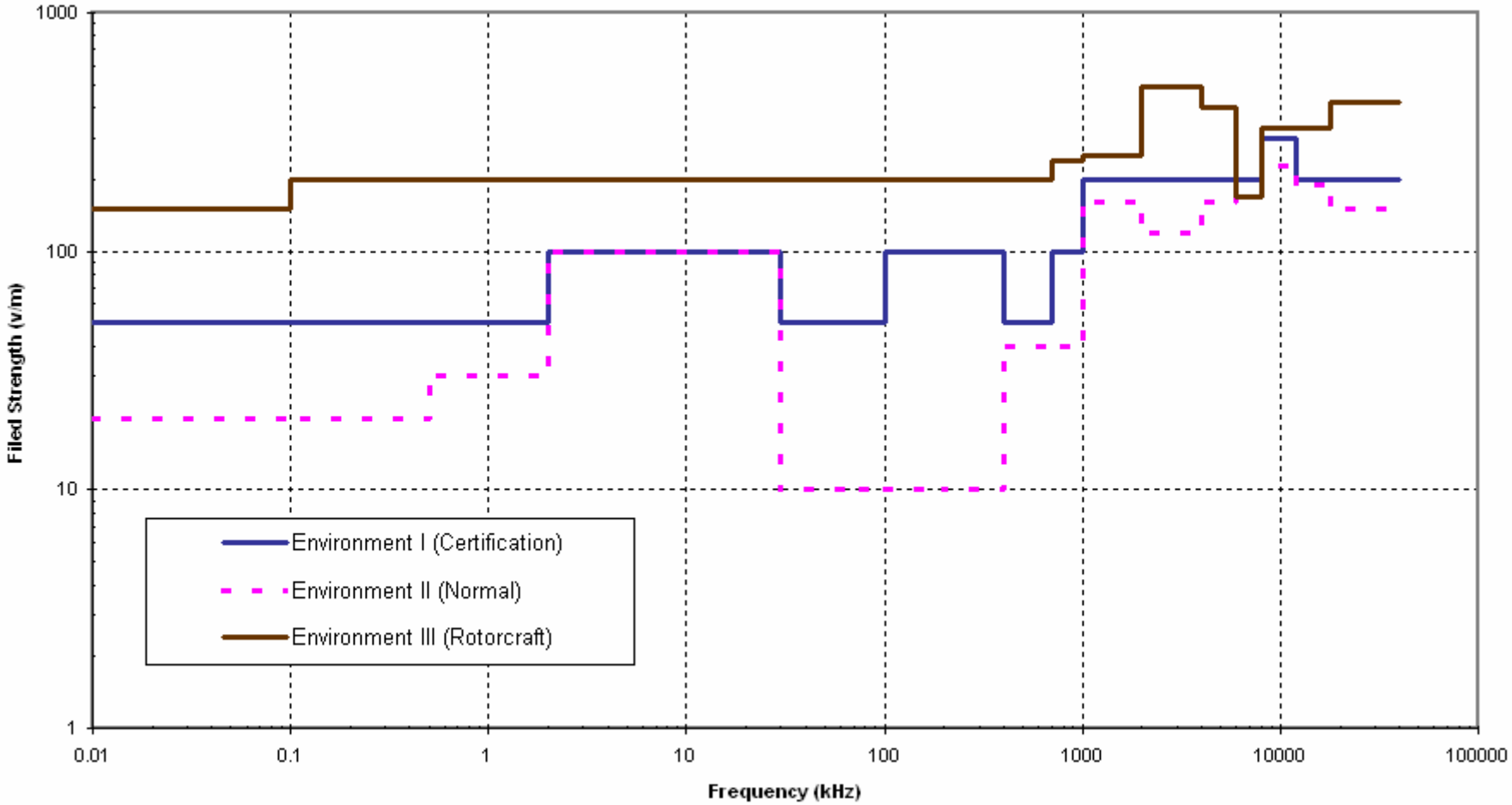
# Table III. - HIRF Environment III (Rotorcraft)

| Frequency | Field Strength (Volts/Meter) | |
|---|---|---|
| | Peak | Average |
| 10 kHz – 100 kHz | 150 | 150 |
| 100 kHz – 400 MHz | 200 | 200 |
| 400 MHz – 700 MHz | 730 | 200 |
| 700 MHz -- 1 GHz | 1,400 | 240 |
| 1 GHz -- 2 GHz | 5,000 | 250 |
| 2 GHz -- 4 GHz | 6,000 | 490 |
| 4 GHz -- 6 GHz | 7,200 | 400 |
| 6 GHz -- 8 GHz | 1,100 | 170 |
| 8 GHz -- 12 GHz | 5,000 | 330 |
| 12 GHz -- 18 GHz | 2,000 | 330 |
| 18 GHz -- 40 GHz | 1,000 | 420 |

# HIRF NPRM *Peak* External Environment



# HIRF NPRM *Average* External Environment



# FAA HIRF NPRM Regulation Summary

| HIRF Failure Condition from §§ 23.1308, 25.1317, 27.1317, and 29.1317 | Performance Criteria | Item the Environment or Test Level Applies To | HIRF Environment or Test Level |
|---|---|---|---|
| Each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the airplane/rotorcraft must be designed and installed so that— | Each function is not adversely affected during and after the time | the airplane/rotorcraft | is exposed to HIRF environment I. |
| | Each electrical and electronic system automatically recovers normal operation, in a timely manner after … unless this conflicts with other operational or functional requirements of that system | the airplane/rotorcraft | is exposed to HIRF environment I. |
| | Each electrical and electronic system is not adversely affected during and after | the airplane/rotorcraft | is exposed to HIRF environment II. |
| | Each function required during operation under visual flight rules is not adversely affected during and after | the rotorcraft | is exposed to HIRF environment III (Parts 27 and 29 only). |

# FAA HIRF NPRM Regulation Summary (cont'd)

| HIRF Failure Condition from §§ 23.1308, 25.1317, 27.1317, and 29.1317 | Performance Criteria | Item the Environment or Test Level Applies To | HIRF Environment or Test Level |
|---|---|---|---|
| Each electrical and electronic system that performs a function whose failure would significantly reduce the capability of the airplane/rotorcraft or the ability of the flightcrew to cope with adverse operating conditions must be designed and installed so that— | the system is not adversely affected when | the equipment providing these functions | is exposed to equipment HIRF test level 1, 2, or 3. |
| Each electrical and electronic system that performs such a function whose failure would reduce the capability of the airplane/rotorcraft or the ability of the flightcrew to cope with adverse operating conditions must be designed and installed so that— | the system is not adversely affected when | the equipment providing these functions | is exposed to equipment HIRF test level 4. |

# Draft HIRF Advisory Circular 20-HIRF

- Draft AC 20-HIRF, “Certification of Aircraft Electrical/Electronic Systems for Operation in the High Intensity Radiated Fields (HIRF)” provides acceptable means of showing compliance with § 23.1308, 25.1317, 27.1317 and 29.1317
- A mix of compliance techniques:
  - Aircraft testing for Level A systems
  - Systems and equipment testing
  - Analysis
  - Similarity

# Compliance Approaches

| HIRF Requirements Excerpts from §§ 23.1308, 25.1317, 27.1317, and 29.1317 | Failure Condition | System HIRF Certification Level | Compliance Test Requirement |
|---|---|---|---|
| Each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the rotorcraft/airplane | Catastrophic | A | System Laboratory Test using HIRF Test Levels derived from aircraft attenuation and HIRF Environments I, II, and for rotorcraft III, or Aircraft exposure to HIRF Environments I, II, and for rotorcraft, III |
| | | A<br>Displays | Same as above, or System Laboratory Test using HIRF Test Levels derived from generic aircraft attenuation in AC 20-HIRF appendix A and HIRF Environments I, II, and for rotorcraft III |

# HIRF Attenuation Tests Performed by NIST

# Compliance Approaches (cont'd)

| HIRF Requirements Excerpts from §§ 23.1308, 25.1317, 27.1317, and 29.1317 | Failure Condition | System HIRF Certification Level | Compliance Test Requirement |
|---|---|---|---|
| Each electrical and electronic system that performs a function whose failure would significantly reduce the capability of the rotorcraft/airplane or the ability of the flightcrew to cope with adverse operating conditions | Hazardous | B | System Laboratory Test using HIRF Test Levels 1 and 2 (same as RTCA/DO-160 Section 20 Category R), or<br><br>HIRF Test Level 3 derived from aircraft attenuation and HIRF Environment II |
| Each electrical and electronic system that performs such a function whose failure would reduce the capability of the rotorcraft/airplane or the ability of the flightcrew to cope with adverse operating conditions | Major | C | System Laboratory Test using HIRF Test Level 4 (Same as RTCA/DO-160 Section 20 Category T) |

# Other Guidance Material

- Users guides for HIRF certification
  - SAE ARP5388, “Guide to Certification of Aircraft in a High Intensity Radiated Field (HIRF) Environment”, January 2001
  - EUROCAE ED-107, “Guide to Certification of Aircraft in a High Intensity Radiated Field (HIRF) Environment”, March 2001
  - These are technically equivalent
- Give detailed HIRF design and test guidance and methods for aircraft and systems

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